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ETV GUIDELINES SERIES

Don't let the 'fashion' bug influence your ETV decisions

Early planning and 'working party' studies can save big sums of money and major headaches in evaluating ETV needs, is the experienced advice by Art Knowles, executive director, Metropolitan Educational Television Association of Toronto

By A. F. Knowles

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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EDUCATIONAL TELEVISION appears to offer schools, universities and other institutions unlimited potential for improvement of teaching, reinforcing, motivating and learning. Television can bring instructional advantages to students of all ages or grades, limited by inadequate facilities, a restricted curriculum or shortages of subject specialists. But in a period of educational change, like that which Canada is going through, there are many pitfalls and dangers for school boards, or universities in being merely "fashionable" in their purchases of educational hardware. This is especially true in the electronics field.

Recently, I had occasion to visit a Canadian university which was considering several major closed circuit TV installations, for teaching and demonstration purposes. Whom had they consulted in drafting their studio and equipment needs, I queried? I was told that the broadcast engineer for one of the local commercial TV stations had been called in, and he had very helpfully told them what equipment, etc. they needed. When I suggested that, of course, such advice must have followed a study of the proposed instructional uses to which the facility would be put, faces became appropriately blank.

(I discovered also, that while adequately trained and experienced in his position as station broadcast engineer, the man in question has no awareness of developments in closed-circuit television equipment designed for educational applications.)

In another situation, a knowledgeable and experienced group of educators, with a wide range of backgrounds in the use of ETV were called on, without advance warning, to advise a team of architects in a matter of hours, on the type and character of TV equipment, costing several hundred thousand dollars, to be installed in studio and instructional areas. When such lack of planning is present, the resulting facilities inevitably have major "bugs" in them, inhibiting seriously their use, and at great cost to the taxpayer.

Often, however, it isn't lack of foresight that affects the establishment of ETV so much as lack of knowledge. It is not just equipment and technology that are involved; changes in curriculum, program sources and materials, new teaching approaches, and unknown expenses may be (and usually are) involved. In most cases, educators need the advice of specialists, especially if elaborate installations are required. There are some things, of course, that school board, university and other staff members can do themselves, saving large sums of money and major headaches.

Major breakthroughs have recently been made in the production of miniaturized, solid-state videotape recorders weighing less than 70 lb. Manufacturers have since developed

competitive models, at price ranges making them economically feasible for major schools, university department use, etc. But (caveat emptor!) none of these newer VTR's produce tapes which are interchangeable for re-play on existing *broadcast* quality models. And a videotape unit produced by one manufacturer cannot be used for playback on a competitor's product. So, it is very important that the equipment be selected according to its intended use or application.

Purchasers should also be aware that, while the newer, less expensive VTR's do not perform at the levels of broadcast quality machines, they will usually do the right job well, within the range of performance required. For example, a vidicon camera and video-tape recorder used for recording pupil speeches in a "Language Arts" class can provide immediate playback for critique purposes of quite sufficient quality for the purpose that the teacher has in mind.

Form ETV study group

Two basic considerations are, first, the importance of early planning, and the creation of "working parties" to consider the range of uses and purposes to be served. And, second, the need for flexibility in selecting equipment or systems with a view to expanding the program, or to be able to accept newer products that may be developed later with more desirable features.

Once a "working party" on ETV Study or Planning group is set up, its first task should be to identify and specify the educational problems and needs in which an ETV or closed-circuit TV approach may be able to help.

Then, the next step is the setting of realistic and specific objectives for the proposed ETV installation to handle. For example, a college of education, or faculty of education, may decide that demonstrations of excellent models of teaching should be videotaped "on location" in the actual (and natural) classroom setting, minimizing the distractions to pupils and teachers in the process, for playback to student teachers. (This is one of the major objectives of the superbly designed and efficiently operated system of the Faculty of Education, University of Alberta, Edmonton.).

Before proceeding further, a committee or "working party" should begin to review the literature, and learn some rudimentary TV terms. Visits to ETV and CCTV installations will help. A file of information should be developed. Discussions of problems and solutions with experienced educational and technical personnel (without "axes to grind") should be held, along with exploration of alternative choices of equipment, types, costs, etc. It is also important, in the very early phases of a study, to explore available facilities, space and construction requirements, which may be seriously affected by long-term policies of the school board or other institution.

What are the requirements?

Questions such as the following should be dealt with, as aids in making decisions about purchases:

- Is the ETV equipment intended to receive and distribute off-the-air programs?
- Will the equipment be used to permit both simple and fairly complex studio presentations?

- Will a complete production studio facility to carry out specific programming objectives be set up?
- Is it intended for a wide range of present and future alternatives that show promise of educational value and that are economically feasible?

Perhaps the most neglected area of concern when an educational institution develops an interest in ETV is around staffing the installation. Too often someone is hired from a local TV repair shop, without adequate technical training or experience in systems installation, maintenance and operation. It is crucial that very knowledgeable people with good technical training and experience, preferably in educational settings, be employed — or be readily available. Excellent training courses are given at some provincial institutes of technology such as the Ryerson Polytechnical Institute, Toronto.

To some extent, every Canadian educational institution that is considering an ETV installation, however simple or sophisticated it may be, can help to provide valuable insight into the particular use undertaken. Every day, ETV activities in studios operated by school boards, universities, and other institutions suggest new combinations of existing facilities and equipment. Also, it would be unwise, and unnecessarily restrictive, to create *sharp* lines separating closed circuit TV and broadcast ETV uses. Future developments will make it possible and desirable, to unite the inputs of many systems, including existing off-air broadcast sources of programs (CBC and private), future educational TV stations, low-power 2500 megacycle or microwave links for connecting buildings on a campus, or between several remote locations. Experimental broadcasts linking class-rooms in Hagerstown, Maryland, and Great Britain have dramatically demonstrated the potential of Telstar to create a truly global learning situation, which in this instance helped to create understanding between students several thousand miles apart.

Plan flexibility into system

Perhaps the most significant contribution to education of a communication system will be the creation of convenient and flexible arrangements that will provide a valuable instructional service to students and staff (and in the case of an ETV station, the community). Within a school or university building, inputs should be installed to make possible "live" originations from a studio, from classrooms, laboratories, playing fields, gymnasia, auditoria, and other areas. These capacities when built in, coupled with the imaginative use of video-tape recording of programs, and the use of mobile or portable equipment, provide exceptional resources.

Discussion of the role of television in education is not crystal-ball gazing about an uncertain future. All new educational buildings in the blueprint stage, or being modernized should be planned for the installation of communications facilities. The system of the present and immediate future should facilitate coordination of all electronic, audio-visual, and other systems essential to the needs of today's administration, teachers, and students.

Of course, fundamental to the foregoing is the belief that modern teaching practices require use, whenever appropriate to a learning objective, of specific techniques, methods and facilities. The process of building the use of educational media into regular practice in the classroom is one in which every up-to-date teacher, specialist and administrator will wish to participate. It is too easy for complacent educationists to take the attitude, that "teachers are waiting for some hint or promise of things to come."

The need is here, experience and research are available, and the equipment and facilities are at hand. Let's make intelligent use of them. ■

HERE'S THE STORY ON VIDEO RECORDERS

How does the VTR work? What can it do? Which features will work best for your ETV needs? Here's the background on what you need to know about using video tape recorders

By DAVID CODLING

SO THAT the new educational tools of TV, educational UHF channels and closed-circuit TV systems can be better understood, this series of articles on *Guidelines to* ETV *Equipment,* will describe the use and operation of the various components of a TV system. We'll start with the one which is possibly the least understood and probably the most useful as far as TV system versatility is concerned — the video tape recorder.

Subsequent articles will talk about classroom receivers; cameras and camera accessories; accessories such as lens, tripods, lighting, sound; and ETV systems.

At the present time there are over a dozen different types of video tape recorders, with new models appearing almost monthly. The chart listing some of the more widely used recorders is intended only as a guide to enable you to see the makes which are available. It was prepared from specification sheets issued by manufacturers; where no information is given in a column, it is because the information wasn't available at the time the chart was being prepared, and doesn't necessarily mean that the feature is not part of that machine.

To help those who have to concern themselves with ETV systems, we will try to sort out the various categories of video tape recorders. To do this, a little background information on video tape recording may help.

Some years ago people in the broadcast industry were urgently searching for a way to store pictures by other means than on film. Magnetic storage eventually provided the answer because it lends itself readily to the electronic signal obtained from a TV camera, the video signal.

If you look carefully at your TV screen you will see that the whole picture is made from horizontal lines, 525 of them to be precise. When you look at one line, from left to right, across the centre of the screen, it will probably change its shade several times as it passes over light and dark areas of the scene. When the line which you are examining is viewed electronically as a wave form, it presents an outline not dissimilar to a jagged mountain range, the peaks representing the white parts of the scene and the valleys the darker areas and the blacks.

Having such a signal the next step was to obtain a magnetic field which would vary in direct proportion to the peaks and valleys, or whites and blacks. This was achieved by presenting the video signal, after suitable preparation, to two magnetic poles spaced apart by a minute gap considerably less than one-thousandth of an inch. Across this gap was formed the required magnetic field which varied proportionally to the video signal, the whole assembly being called a *video recording head*.

The next step was to magnetize something with the magnetic field so that a record could be kept. This something was polyester-based tape coated with a ferrous layer which could be magnetized. If this tape were to move past the video head the magnetic changes would be strung out in sequence corresponding to the changes in white and black of our line on the TV set.

This was all fine and good but there was a speed problem. On a TV picture, every other line reoccurs 30 times a second; that is, all the odd numbered lines of our picture occur one after another 30 times a second, and the even lines 30 times a second, to interlace. These are the odd and

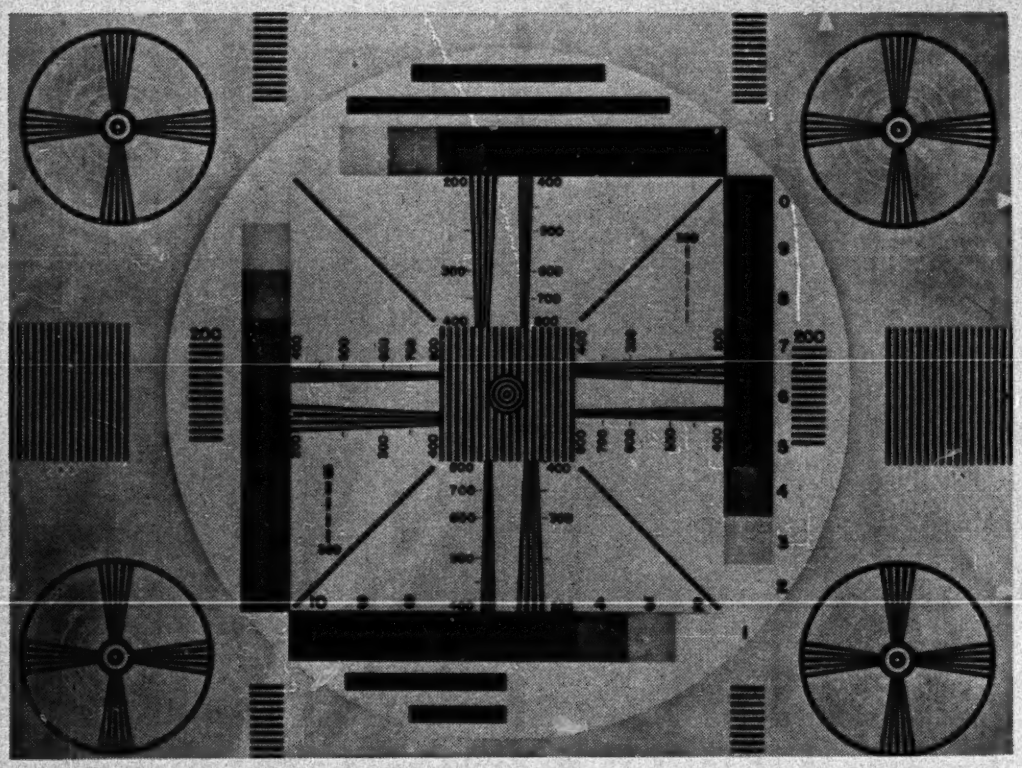

Diagram 2: frequency response, which should be as high as possible, is given in terms of line resolution measured on RETMA chart, above.

even field, the two combining to make a TV frame or full picture.

Hence, the frequency of occurrence of sequential lines is 15,750 every second. So, the video recorder head has a lot of magnetic changes to cope with every second. *This is one of the key factors which separate the good recorders from the poorer ones*—the ability to respond to the rapid changes in video signal—whether or not it will miss small or fast changes of magnetic variations. This is the measurement of the instruments speed response known as *frequency response* or bandwidth. This frequency response is all important. It determines whether that fine detail of a picture and sharp edges can be reproduced to make the picture more usable.

So, we have decided that the ability to record as many as possible of the shade changes on our lines is a must. But there may be several 100 of them on one line and 15,750 lines every second. Obviously the further apart on our tape we can spread all these changes, the better things will be. It could be arranged for the tape to move past the little magnetic gap of the video head at fantastic speeds, but this is mechanically impractical.

Therefore, it was decided to move the video head at high speeds and the tape at low speeds. This still had the same effect of providing a high head to tape speed which can be looked upon as the writing speed. In the video tape recorder of the TV broadcast industry, the load is shared by four heads at 90° to one another around the edge of drum rotating in a horizontal axis.

The video tape, two inches wide, is moved horizontally past the drum and each video head in turn lays down its magnetic pattern in a stripe across the tape, recording 16 lines on each stripe. This, although providing the highest writing speed is a bulky and complicated machine.

There is no doubt that these broadcast machines use the best system. But the cost varies between $50,000 and $100,000 for one machine.

Further research brought the development of helical scan and lower cost tape recorders. In the helical scan machines the tape is wrapped around the rotating head drum, starting low down and rising upwards as

MAKE	WIDTH OF TAPE	TYPE NO.	COUNTRY OF MANU-FACTURE	USE FOR WHICH DESIGNED	NO. OF HEADS	HEAD SPEED RPM	WRITING SPEED INS/SEC	FREQ. RE-SPONSE	LINE RESO-LUTION	TAPE INTER-CHANGE ON SAME MODEL	TAPE SPEED IN./SEC.	LENGTH OF PLAYING TIME	SIGNAL TO NOISE	STILL FRAME	EXTRAS, BENEFITS, ETC.	PORT-ABLE	WEIGHT LBS.	EDUCA-TIONAL PRICE $
Ampex	2	VR1000C	U.S.A.	Broadcast	4	14,400	approx. 1,500	4.5Mcs	up to 600	yes, also w/other models	15	96 min. 14" Reel	42 db	No	Automatic & Vert. Electronic edit	No	1,900	50,000.
Ampex	2	VR1100C	U.S.A.	Broadcast	4	14,400	1,500	4 Mc/s	approx. 450	Yes, and w/o. mod.	15/7½	96/192 min.		No	Transistorized Electronic edit	No	800	40,500.
Ampex	2	VR2000	U.S.A.	Colour Broadcast	4	14,400	1,500	4.2 Mc/s	approx. 500	Yes, and w/o. mod.	15/7½	96/192 min.		No	As for VR1000C plus colour	No		approx. 70,000.
Ampex	2	VR660	U.S.A.	Portable Broadcast	2 @ 180 deg	1,800	650	3 Mc/s	approx. 400	Yes	3-7	5 hrs. 12½ R	40	Yes	2nd Audio Track simple electronic edit	Yes	100	approx. 9,000.
Ampex	2	VR1500	U.S.A.	CCTV	2 @ 180	1,800		3 Mc/s	approx. 400	Yes	3-7	64 min. 8" R	40	Yes	2nd Audio Track	Yes	120	
Sony	2	BV 100 BV 120	Japan	Broadcast	1 Video 1 Sync			3.4 Mc/s		Yes	4.25	84 min.		Yes	Slow Motion	No		
RCA	2		U.S.A.	Broadcast	4	14,400	1,500			Yes, and w/o. mods.	15	96 min. 14" Reel		No		No		
Dage Navico	1	DV 300	Japan	CCTV	2	1,800	833	Approx. 4 Mc/s	330	Yes	5.91	63 min.	38	Yes	Slow Motion Audio Amp. & Spkr.	Yes	147	approx. 8,500.
Ampex	1	VR7000	U.S.A.	CCTV	1	3,600	1,000	3.5 Mc/s	350	Yes	9.6	63 min.	42	Yes	Audio Amp. & Spkr. RF Out	Yes	100	3,505.
Sony	1	EV200	Japan	CCTV	2 @ 180		550	3.2 Mc/s	325	Yes	7.75	63 min. 8" Reel		Yes	2nd Audio Track Slow Motion	Yes	70	4,250.
Philips	1	EL3400	Holland	CCTV	1	3,600	930	2.5 Mc/s	approx. 250	Possible	9.0	45 min.		No	RF In RF Out	Yes		2,850.
Precision Instruments	1	PI3V PI4V	U.S.A.	CCTV	2 @ 180	1,800		3.5 Mc/s		Yes	7.5 0-85	96 85		Yes	Variable Speed	Yes	75	9,462. 12,490.
Ampex	1	VR6000	U.S.A.	Home T.V.	1	3,600		Est. 2.2 Mc/s	225	Possible	9.6	63 min.						approx. 1,600.
Sony	½	Video-corder	Japan	Home T.V.	2			Est. 1.5 Mc/s	approx. 200	No	7.5	30 or 60 min.						approx. 500.
Concord	½	VTR 600	U.S.A.	Home T.V.	2			Est. 1.5 Mc/s	220	No	12	40		Yes				approx. 500.
Pana-sonic	½	Tape A Vision	U.S.A.	Home T.V.	2			Est. 1.5 Mc/s		No	12	40		Yes				approx. 1,500.
Woolen-sak	½		U.S.A.		2			Est. 1.5 Mc/s	approx. 150	Possible	7.5							approx. 1,600.

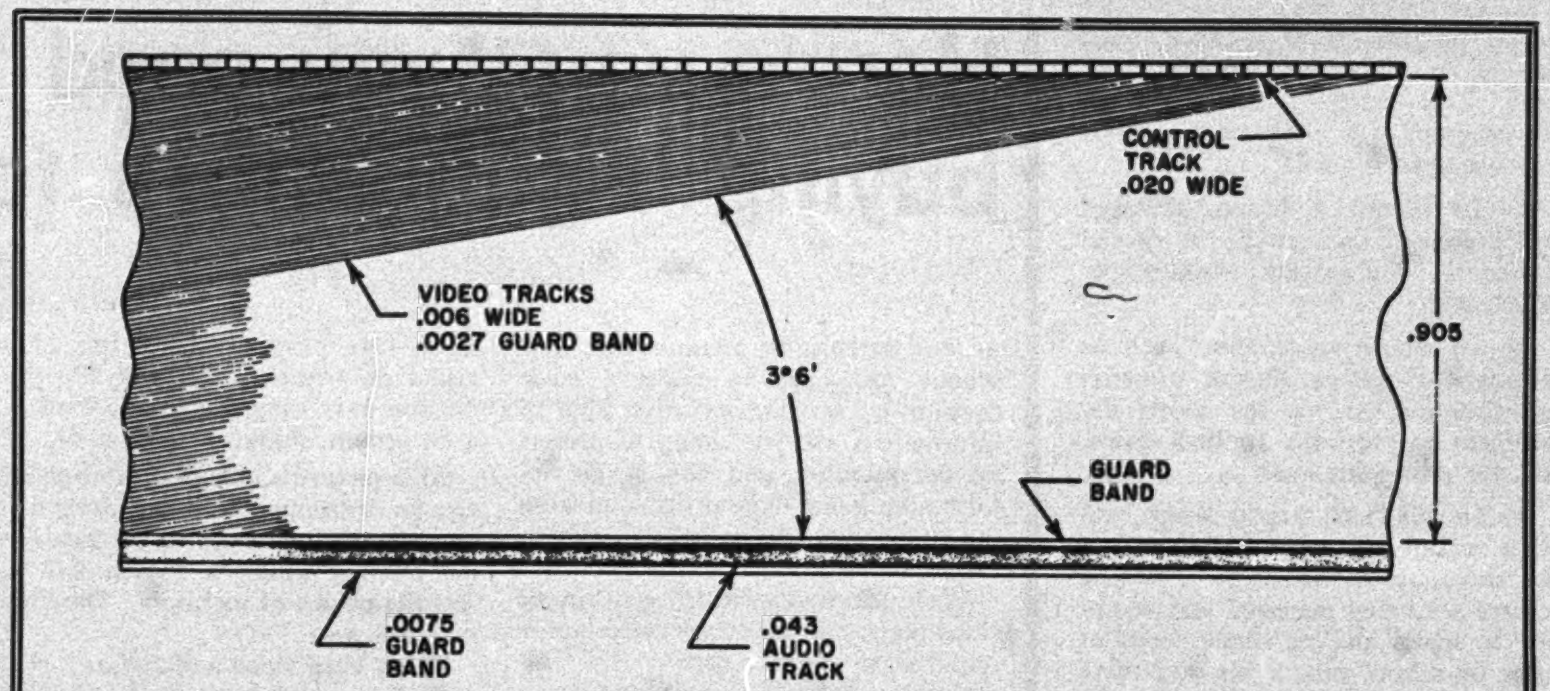

Diagram 1: video head drum rotates 60 times per second so that each pass records one field of information.

it goes around, leaving the drum above the incoming tape. The video head, just a single one in almost all machines, is mounted on the edge of the drum at a height just at the bottom of the tape as it leaves the drum.

As the drum rotates, the head goes around with it, moving across the tape to the point where the tape enters the drum, leaving the video information in a long diagonal stripe from bottom to top (see diagram 1). The length of the stripe obviously affects the writing speed and consequent frequency response as it does the speed of rotation of the drum. Generally, the drum rotates at 60 times per second, so that each head pass records one field of information.

Another factor affecting writing speed is the width of the tape, particularly as only about 90% of the width is usable. Experience has found that one-inch tape is best for this kind of recording, taking into account many factors, not the least of which is the space available to lay down the longest stripe (higher writing speed). Subsequent fields of 262½ lines each are laid down as stripes parallel to one another as the tape moves forward.

To be able to use this recorded information, we must be able to get back the information accurately from the tape. To help do this, the VTR machine records along the top edge of the tape a series of reference or cue pulses one for every TV field. These act in a similar way to sprocket holes on a film, the difference being that the video head speed adjusts itself to the occurance of the cue marks. This action is known as a *servo system* and is essential if the video head is to move accurately over the top of the recorded stripe of information.

Also essential is a very accurate and unchanging tape path. If the tape head is sloppy it would be impossible to ensure that the head finds the video information which is only 6-thousandths of an inch wide. This is particularly true in the case where a tape has been recorded on one machine and is to be played back on another. This is the second feature that *must* be considered: **tape interchangeability.**

This factor alone extends the usefullness of any tape recorder by a factor of four. Interchangeability can only be obtained on a machine which has first class engineering on all tape track components, a servo system which is rapid to react, with a wide speed control range.

Such a machine has built-in adjustments which can be made by the factory or a qualified serviceman to ensure 100% interchange of tapes between machines of the same manufacture. This kind of precision machinery cannot, at the present time, be obtained for less than $3,000. This is the big dividing line between closed circuit TV tape recorders for use in schools and home recorders designed and made at less cost for recording your favorite TV program at home.

The following, therefore, are the important facts about which you should ask your dealer when you are thinking of purchasing a videotape recorder:

- the frequency response or bandwidth should be as high as possible
- can the machine play tapes recorded on any other recorder

Note: You may find that the frequency response is given in terms of line resolution, which is directly associated with frequency response. Line resolution is measured on a RETMA chart (see diagram 2). Line resolution is the ability to distinguish the lines before they merge together on the vertical wedge-shaped part of the chart markings.

If the recorder or TV camera produces or reproduces a picture of the chart on a monitor on which the lines merge together and become indistinguishable at the number 400, then either the camera or recorder has a maximum vertical resolution of 400 lines. This number of lines has no direct connection with the scan lines which we considered earlier.

The application of tape recorders falls broadly into four categories:

1) To record a broadcast or off-

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the-air program from an educational UHF channel carrying school broadcasts. This enables a teacher to use the program at a convenient time or to reuse it subsequently.

2) To record a lesson prepared and presented in a studio or special classroom by a teacher, visiting specialist, etc.

3) To record on-location such as visiting a laboratory, theatre, museum or exhibition, or for the sports department to record a football game, etc., for post-game analysis.

4) To playback tapes which another school has made under any of the three above headings. Dubbing centres are being prepared and equipped to make and distribute tapes of films or school broadcasts and these will be available in the form of a library service.

Now that all these things are possible, leading manufacturers of VTR machines are trying to make life even easier by providing facilities on their machines such as:

☐ Stop motion pictures for detailed examination, by stopping the forward motion of the tape. This can also be useful as a tape ready to roll cue.

Fast rewind with accurate tape position indicator counters, so that a teacher can go back and rerun any section of the lesson.

☐ Built-in loud speakers and sound amplifiers.

☐ Output terminals for extension speakers.

RF as well as video inputs and outputs so that a normal TV receiver can be used in the place of a monitor, although picture quality deterioration generally is evident using this method.

☐ Sound may be recorded either with the picture recording or afterwards. Obviously, synchronized recording is essential when a person is "on camera", but commentary, remarks, or instructions can be added later as the instructor is watching the video being played back.

☐ Metered video and audio record and playback levels for the best quality pictures.

☐ Future conversion to record color.

A final point is service, maintenance and spare parts and training of your staff in the use of the recorder and its associated equipment. The video head is a part which will wear out perhaps in six months of average use (500 hours). So check how easy they are to replace and the cost of replacement heads. ■

Here's what you need to buying TV monitors for

BEFORE BUYING TV monitors for your school you have to make a basic decision on two factors: what kind of information are you going to display on the monitor, and how is the information going to be distributed from the originating source to one, two or 20 monitors.

We'll deal first with the most simple situation, where an inexpensive unit is required to show a regular TV program to a class. This unit could be a normal commercial TV receiver or a classroom TV receiver. In either case, several basic things should be considered.

1) Size of screen. A minimum of 23-in. is recommended for group viewing (this dimension, incidentally, is often the corner-to-corner diagonal measurement, not the width of the screen)

2) Picture resolution (see Video Tape Recorder story, October issue) and the ability to show detailed changes of shading, should be as high as possible

3) Light output of the tube, which will be in foot lamberts, should be at least 28 FL

4) Audio frequency response. The widest range is the best, and a good audio output level of at least 1.5 watts

5) Rugged cabinet. Types referred to as classroom monitors have strong cases fitted with lockable doors at the front, and carrying handles for easy transportation.

This receiver will enable you to receive channels between 2 and 13 known as the VHF (Very High Frequency) band. Now that several major centres across Canada are considering fulltime educational channels, it is well to enquire about a UHF (Ultra High Frequency) band as this will probably be the frequency range used for ETV stations.

Monitor requirements for CCTV systems

Now we must consider monitor requirements in closed circuit TV systems. This system may perhaps be a single fixed camera with a wide-angle view of a teacher or instructor in a classroom, being relayed to one or more other classrooms. Perhaps it's a video tape playback from the audio visual department, or a full TV production unit using a system console in a classroom, studio or laboratory.

This picture and sound information can be distributed from the system in any one of three ways to the monitor, the method which is chosen will effect the choice of monitors. The three methods are:

- By pure video and audio
- By modulated video and modulated audio (known as RF, Radio Frequency)
- By video and modulated audio

Type of TV monitors needed for each system

Next we look at the advantages and disadvantages of each system and the type of monitors required.

1. Using pure video as obtained from a TV camera or an "off the air" tuner, the very best possible picture will be available to drive a high quality monitor. This quality is most desirable when the subject of the lesson is a lab experiment, a view into a microscope, a lesson containing printed explanations, illustrations, or detailed diagrams.

The maximum recommended total distance for video distribution is 1,000 feet using high quality coaxial cable. Over this distance the signal can loop through three or four monitors without serious deterioration or signal. The term "loop through" means that the video signal is fed into either of the two video connectors on the rear of the monitor and out of the remaining one on to the next monitor. The end of the line, however, must be terminated with a 75 ohm termination which screws into the last connector on the last monitor.

If more than four monitors are to be fed with the same signal the line should be split by a video distribution amplifier. This distribution amplifier (often referred to as a DA) will provide four or eight video feeds equal in amplitude to the source video signal. Video distribution amplifiers are available as self-contained units, or as plug-in units in racks, fed by one power supply.

The monitors used with this kind of system are usually high resolution

know about your school

video monitors, generally of the type manufacturered by Conrac. These are available in various models of several standards from industrial to general TV, and broadcast quality master monitors. At least one model has a special flat-faced tube and the cabinet can be obtained fitted with studs, instead of handles, for mounting on a pedestal or ceiling mounting bracket. These video monitors generally have a bandwidth of 10 Mc/s and a picture centre resolution of 800 lines giving a clear, sharp picture.

Also available and capable of handling video are some special type of classroom monitors which are factory-modified TV receivers able to accept video input. A function switch for TV or video is mounted at the side of the cabinet. This type of monitor will give a resolution of approximately 350 lines when fed with video compared with 220 to 250 for a normal TV signal.

Audio to accompany this system may be fed through an audio amplifier of sufficiently high quality to maintain a good frequency range, and then along ordinary insulated wire to loudspeakers located near the video monitor.

2. The second method of distribution is modulated audio and visual. By modulation we mean that the picture information is superimposed on a carrier signal, somewhat similar in effect to adding color dyes to a fast-moving stream of water. The RF or carrier signal has no picture value anymore than the clear water has color, but when the video signal or dye is added, the picture, or color, is carried along to a distant point where it can be retrieved by a filter or demodulation system.

How audio, video outputs are fed in

When the video from a source is modulated, it can be added to the carrier frequency of any of the 12 TV channels, preferably one which isn't being used in your particular area by commercial TV. The audio information can be fed into the same modulator and is processed in a similar manner. The two outputs, being separated slightly in carrier frequency, can be fed along the same conductors.

Taking this a step further, other video information from another camera, for example, can be modulated on another TV band frequency and can go on the same wire simultaneously. This system is obviously a very useful way to distribute, on the same wire system, several different lots of video and audio information. To monitor these various signals the wires are connected via an impedance matching transformer to the antenna terminals of a TV or classroom receiver, and the set is tuned to the channel number which is carrying the picture information you require.

Can send six lots along same cable

Other TV sets on the same system may be extracting different pictures from the same cable, using a different channel number. The advantage, then, is the ability to send up to six lots of picture and sound information along the same cable. (Six would be the maximum as it is advisable not to use adjacent channels, so either odd or even numbered channels are used.)

The RF signal can be sent over greater distances than video, too, up to 2,500 ft. at least, without serious deterioration. The disadvantages in an RF system are the considerable additional cost for modulators, one for each signal source, and the limiting resolution capability of a TV receiver (200 - 250 lines as mentioned previously). The RF signal can, of course, be demodulated at its destination by a wide band demodulator and the resulting video information fed to a high resolution video monitor. But this again adds expensive equipment at each receiving point.

3. Distribution by video and modulated audio is a system used less often. Its purpose is to enable the audio pick-up associated with a particular scene on camera, to be switched to other audio pick-up associated with another scene when the camera selection is changed. This is known as "audio-follow-video" switching.

The audio and video are then distributed on the same cable, and the audio demodulated and separated from the video at the monitor. This system uses a video monitor as in system No. 1 and a regular loudspeaker after the audio demodulator. The cost, however, of the various modulators, high quality switcher and demodulators, is rather high.

General hints on use of classroom monitors

Here are some general hints on the use of classroom TV monitors:

☐ Don't try to economize on monitors; 15 students per monitor should be the maximum. If necessary, put a monitor at the back of the room and turn half the class around.

☐ Invest in stand with wheels for the monitors. The stands should be at least 4 ft. high, with a good wide wheel base for stability, but not too wide or too high to prevent it from going through doorways.

☐ Check for good quality because no matter how exotic and expensive your TV cameras and systems, the resultant picture is only as good as your TV monitors. ■

Types of monitors now available

Common Types Available	Example	Model No.	Approximate Cost Educational
Video, high quality in metal cases	Conrac 23"	CVA23C	$444.00
Classroom type, for video, VHF and UHF	Admiral 23"	E55YU	239.00
Classroom type for VHF and UHF	Admiral 23"	E55U	220.97
Classroom type for VHF only	R.C.A. 23"	TE3543	213.95

(A factory installed video input modification is available for the TE3543 at $30 extra)

PRICE RANGE (EDUCATIONAL)	SOME OR ALL OF THE FEATURES	RESOLUTION	USES
Up to $500	Non-professional cameras Random sync, oscillator controlled	200 to 400 lines	Home TV Some Industrial application.
$500 to $1,000	Industrial sync, crystal controlled Some variable adjustments Full scan protection Automatic Target	400 to 650 lines	Many Industrial applications. Static views, timetables, etc. Many general closed circuit TV uses, where small detail is not required.
$1,000 to $2,500	2:1 interlace or EIA sync May be internal or external sync drive All variable adjustments Some adjustments remotely controlled 3 or 4 lens turret Scan protection Automatic Target often for 4000:1 light variation Tally lights Plug in circuit boards and sub-assemblies	650 to 800 lines	Closed circuit TV Used for detailed work. Slides, books, photographs, microscopes, etc. can be used singly or in systems of 2, 3, or 4 cameras. Can be used in remote locations and remotely controlled. With small modifications may be used in film chains. Used where a clear sharp picture is required.
$2,000 to $5,000	Full EIA sync. Internal or external or both Viewfinder types All variable adjustments Some adjustments remotely controlled 3 or 4 lens turret Scan protection Automatic Target Tally lights Plug in circuit boards and sub-assemblies Intercom systems using camera headsets	650 to 800 lines	As above, plus the use of Viewfinder in studios, laboratories, arenas, theatres. Any time any artistic camerawork is required, using a cameraman.

Chart above lists various types of television cameras as a guide to price range, features and uses.

Rundown on closed-circuit TV cameras

Here's what to look for in CCTV cameras, and how each type can serve your needs

By DAVID CODLING

THREE NAMES which you will hear being tossed about when a discussion on television cameras is under way are IMAGE ORTHICON, PLUMBICON and VIDICON. These are the main tubes inside TV cameras, the heart of the matter, as it were. Their function is to change the light reflected from a scene into a string of electronic signals.

The first, the *image orthicon*, is the tube used in black and white broadcast type cameras. They are relatively large, 3 or 4½ in. diameter by 16-in. long, and very expensive ($2,000 each). They provide pictures of very high quality, but their life is quite short, 1,500-2,000 hours. Consequently only the broadcast industry, using $20,000 camera chains can afford to use them.

Plumbicon is a registered trade name for a tube which has been developed by Philips. It is less expensive than an image orthicon, and has very good sensitivity at low light levels. Its operation and size are similar in many ways to the vidicon which we will discuss in a moment, except that a special lead monoxide component is used as the photoconductive material. The present cost of a plumbicon tube is between $900 and $1,500, depending upon the application, and the cameras in which they are used vary from $6,000 to $20,000 with a performance in most respects equal to image orthicon cameras.

The name *vidicon* is by far the most common tube in closed circuit type TV cameras. This tube is one inch in diameter and about 6½-in. long. As mentioned previously, the purpose of this tube is to change the light reflected from a scene into an electronic signal.

Here's how it works

Briefly, the method in which this is achieved is as follows:

The light from the scene is brought to focus by the camera lens, on a layer of material inside the vidicon faceplate, whose resistance changes when subjected to light. This is known as a photoconductive layer, and may be a substance such as amorphous selenium of uniform thickness. (In a plumbicon tube this material is lead monoxide.)

This layer is called the target, and the material from which the target is made is in its normal state an insulator with the property that, when subjected to light, its resistance decreases. From the rear of the vidicon, an electron gun shoots a narrow beam that scans the image on the faceplate in a precisely calculated pattern of movement.

When this beam encounters a por-

tion of the photo conductive layer, whose resistance has been lowered by light focused upon it by the lens, the electron flow is increased. This increase is detected in the circuit connected to the photo cathode target causing a voltage change across a load resistor.

This voltage then is directly proportional to the amount of light which was originally focused upon the photo cathode by the lens. Hence, we have a voltage signal which varies in proportion to the light on the photo cathode as the beam scans the area of the target. The pattern of scan is very important, being from left to right, and top to bottom, similar to the eye's movement in reading.

The modification to make this analogy more accurate, is that you would read every other line to the bottom, and then return to the top and read the lines which you had omitted. The electron beam scans in this manner, the resultant scan being two interlaced fields. When the lines are equispaced, as the lines in a book, the scan is said to be locked in a 2.1 interlace or partial EIA synchronization. If the line spacing were to be random, then the scan is called random interlace or industrial synchronization.

To obtain 2:1 or locked sync, the synchronozation pulses must be provided by a sync generator, either inside or external to the camera.

The locked sync or external sync is most desirable when more than one camera is being used, and your program or lesson is being built up by switching between the cameras, also for fading, mixing, and superimposing camera outputs. The sync generator provides the pulses to ensure that the scan starts and ends at the same time in each camera, thus avoiding the picture tearing or rolling which would otherwise be the result if the scan were random, and switching etc. attempted.

Returning for a moment to book reading; at the end of each line the eye and the beam in the vidicon has to retrace to the start of the next line. In the vidicon, a switch off, or blanking pulse, is generated for each line (horizontal blanking), and for returning from the bottom right to the top left (vertical blanking). This is so that retrace lines are not visible.

EIA sync has been briefly mentioned already. This is the type of sync provided for, or by a camera which is to be used in a system of broadcast standard. EIA sync has pulses similar to 2:1 locked sync, also horizontal and vertical blanking, plus extra pulses called equalization pulses, during the vertical interval. However EIA standards lay down very definite sizes and durations for all these pulses, so that all broadcast TV cameras will be compatible one with another. Generally speaking EIA sync is always desirable, as the more accurate and precise these pulses are, the more stable will be the resulting picture.

What types available

As the purpose of this article is to discuss ETV hardware, we will stay with the vidicon camera and look briefly at the various types available, and discuss the terms which may be found on a specification sheet.

There are available several camera models, which cost only $500 or less; these are generally of Japanese manufacture, usually well engineered, and containing all the essential circuitry. At such a low cost, they have industrial sync with no positive interlace, and an inexpensive vidicon tube. They are often sold with the home type video tape recorder to make home video tapes (the successor to home movies).

$500 to $1,000 range

The next price range, $500 to $1,000, includes probably at least one camera from the range supplied by all of the better-known manufacturers of vidicon cameras. These cameras may have a crystal which will oscillate at a precise frequency to control the industrial type sync, linearity controls and perhaps height and width controls for the scan may be included.

The resolution will be in the order of 400 to 650 lines when viewed on a video monitor. They will also probably include such features as full scan protection, that is to say, if the circuits which cause the beam to move left to right or bottom to top should fail, the beam is shut off. If this were not so, the line would scan in the remaining direction, i.e. up and down if the horizontal circuits failed, and within a matter of moments would burn a line vertically down the centre of the target layer, permanently damaging the vidicon.

Another feature may be an automatic target circuit. This circuit automatically adjusts the voltage of the target to, in effect, reduce the sensitivity of the vidicon when it is moved from a dark to a bright scene. If this were not so, vidicons set for dark scenes would show a white mess when pointed at bright scenes, such as a sky or rear lit transparency. The average autotarget can cope with light changes in the ratio of 3000:1 or better.

$1,000 to $2,500 range

The next price range is $1,000 to $2,500, which will purchase all but the most sophisticated of vidicon cameras. The lower end of this scale will include cameras with positive 2:1 interlace, and the upper end a full EIA sync generator. Their resolution will be between 650 and 800 lines which is usually as high as is normally required. Other features may or may not all be included, depending upon the uses which the manufacturer had in mind.

However, there will be a full range of adjustable controls, some internal, to be adjusted only by a technician. A turret for mounting several lenses is always a useful feature, to enable wide angle or close up views to be selected. It isn't always necessary, and often not desirable to have the sync generator built into the camera.

When several cameras are being used simultaneously, they can all be driven from one external sync generator built into the control console. If this is the case, the cameras have to be fitted with thick camera cables so that the sync, drive, and blanking pulses can be fed to each camera. To be able to receive and process these pulses inside the camera, a small buffer amplifier must be fitted.

The fact that a camera cable is necessary for an externally driven camera, is used to advantage by some camera manufacturers to enable them to provide remote controls for some of the more essential camera adjustments. This is an especially useful feature when the cameras are mounted in a remote location, away from the operating technician.

With the remoted controls, he would be able to adjust intensity of the beam inside the vidicon, the electrical focus of the camera, set the level of the target voltage which is effectively a contrast control, and the "set up" control which makes the dark areas more black or less black. These are the four controls which are normally remoted, although mechanical focus and turret rotation can also be remotely operated if the camera is fitted with electric motors to drive them.

A further variation

A further variation on the sync generator situation is a camera fitted with both a sync generator and a buffer amplifier, or one fitted with a sync generator which can provide pulses to drive other cameras. All these variations are available and it depends upon the application which you have as to the type to choose.

A final warning when using external drive cameras, with camera cables. Check on the maximum length of cable which the manufacturer recommends. This will prob-

ably vary between 100 and 500 ft. To exceed the specified length may result in instability, as the different pulses are subjected to different delays along the cable, and may get out of synchronization one with another.

Most expensive type

The most expensive vidicon cameras in the range of $2,000 to $5,000 would include most cameras with viewfinders. These are either built into the camera, or are detachable monitors fixed to the top of the casing. They derive their picture signal from inside the camera, but are generally self contained as far as circuits are concerned. When the camera is a roving kind in a studio or laboratory, being operated by a camera man, the viewfinder is invaluable to correctly frame the scene. Viewfinders can be prefabricated, and often are, by using a small transistorized monitor attached to some part of the tripod, or they have even been seen tied to the top of a camera with string.

Points to remember

Checking over points to remember: Decide if internal or external sync is required for your cameras. Internal sync gives a freedom from a console and thick camera cable. External sync is necessary and often more economical if several cameras are to be used, and switching and dissolving between cameras is to be attempted. If you wish to remote control the adjustments, and have tally lights, a camera cable is required. When the camera is to be a roving type on a tripod and dolly, a viewfinder is a great asset.

If you require a picture without noticeable shading when the light level at the scene is very low, plumbicons may have to be used.

Special applications, such as looking at some types of film, or X-rays, may require the video polarity to be reversed. Other special applications may require the picture to be turned upside down or reversed, left to right. These features are available on some cameras, and can be added to others by inexpensive modifications. ■

Here's the small but essential items that go with ETV equipment

By DAVID CODLING

NEXT MONTH'S article will discuss complete ETV systems. Before we are ready to think systems however, we should consider the numerous smaller but essential items which go with cameras, monitors and videotape recorders.

When listed together, these items, such as lenses, tripods, mountings, audio units, microphones, intercoms and lights can amount to a sizable proportion of the expenditure. The following will consider their special features.

Lenses for almost any type of vidicon cameras have a standard thread mounting known as C mount. There are multitudes of lenses for every purpose, however, we can generalize and say that lenses for vidicon cameras will divide themselves into three sections:

1. Wide angle lenses
2. Close up or telephoto lenses
3. Zoom lenses which are constructed so that the multiple lens element inside can be varied in position relative one to another, so that the resulting combination can be either wide-angle or close-up.

The factor which decides the category of a lens is the focal length figure, measured in either millimeters or inches.

The shorter the focal length of the lens, (e.g. 12.5 mm to 25 mm) the wider will be the field or angle of view. To illustrate this, say that your camera is fixed in front of a large chess board, ignoring for a moment the TV aspect ratio, we can arrange that with a wide angle 12.5 mm lens we can see all 64 squares (8x8). Now we change to a 25 mm lens, without moving either camera or board, we will see only 16 squares (4x4), a 50 mm lens will see only 4 squares (2x2) and a 100 mm lens, only 1 square.

In other words, each time the focal length is increased by x 2, the angle of view is reduced by half. The table of typical lenses gives the angular field of view of each lens and a little mathematical exercise will soon determine the best lenses for your application.

Every lens has two adjustment rings, one to adjust the focus and the other to vary the amount of light which the lens will admit. This second item is a major factor determining the usefulness (and cost) of a lens, and is referred to as the *f* stop. (*f* is for *factor* or relationship of the focal length divided by the aperture or effective diameter of the light access).

The LOWER the *f* stop, the better the lens, as it will admit MORE light from the subject, resulting in a better picture from the camera, when the ambient light level is low.

The common *f* stop range is fl.4, f2.0, f2.8, f4.0, f5.6, f8.0, f11.0, f16, f22. (Note the maximum aperture may not be equal to a standard number, but will be found engraved on the lens, and may fall between two standard numbers). Every stop will increase (or decrease) the light admitted by a factor of 2. A second, important effect of the *f* stop setting is how it controls the distance through which objects will remain in focus.

Say your camera is looking at a row of fence poles going away from the camera, and the focus is set for the 10th pole, with the lens wide open (at the lowest *f* stop) probably only the 9th, 10th and 11th poles will be in sharp focus, the rest will be blurred. As the aperture is closed and the *f* stop increased, more and more poles will come into focus both towards and away from the camera to infinity. This is the depth of field which increases as the lens is closed down or the *f* stop number increased.

The whole subject of lenses is very complex and a clear understanding is required to ensure the most effective use of your TV equipment. Some ETV equipment suppliers will have a detailed instruction booklet which they will be happy to supply.

Brief guide to lenses

1. Decide upon a useful range of lenses; a wide angle (12.5 mm will give a 60° field of view); a medium or standard 25 mm lens; and a close-up lens either 75 mm or 100 mm, are all favorite sizes.

2. Buy lenses with *f* number going down to about f1.8 if possible (below f1.8 the cost rises very sharply, above fl.8 is not as useful in low light situations).

3. Make sure that lenses are of rugged construction. Some types are made in such a way that the elements may be reset if dislodged or replaced if damaged. Other types have to be replaced completely which is more expensive.

Zoom lenses, as mentioned, have

LENS ANGULAR FIELD OF VIEW TABLE

Lens Focal Length in mm	Horizontal Angle Approx.	Vertical Angle Approx.	With the Camera Width of View	12 ft. From Subject Height of View
12.5	60°	45°	12′	9′
25	30°	22.5°	6′	4′6″
50	15°	11.25°	3′	2′3″
75	11.25°	8.5°	2′3″	1′8¼″
100	7.5°	5.75°	1′6″	1′1½″
150	5.75°	4.25°	1′1½″	10″
200	3.25°	2.5°	9″	6¾″

movable elements inside them which can vary the focal length up to a maximum ratio of 10:1 for normal TV use.

These lenses may be fitted with a mechanical linkage device to remotely control the zoom action, and at quite an increased cost the focus mechanism may be remotely controlled too.

The format of these controls depends greatly upon the lens and the physical construction of the camera on which they are mounted. The operational advantages of being able to control the zoom from the rear of the camera are obvious, as the cameraman is able to make full use of the versatility of the lens with the least inconvenience.

The correct method of setting up a zoom lens is worth mentioning, as it is often misunderstood. With the lens at zoom out (wide-angle) the *camera focus* should be set on the subject by positioning the vidicon for best focus. Then zoom in (close-up) and set the focus of the part of the subject still in view by adjusting the *focus ring on the lens*. When this is done the zoom lens will be in focus through its whole range. Only this method of setting up will achieve the desired result.

Mounted on tripods

For studio use vidicon cameras should be mounted on a suitable tripod or pedestal assembly to enable their repositioning between "shots".

Several types are available with the models by Quickset probably the most numerous. Range includes three strengths, Samson, Hercules and Gibraltar to carry loads of 40 lbs., 80 lbs. and 200 lbs., respectively. These are all folding tripods which become mobile when fitted to wheel units called dollies. Each type has a range of heads available for various applications, or adaptors to accommodate motorized pan and tilt units.

Heads most suited to studio TV use are either the less expensive friction type or superior cradle mountings. The principal consideration is that the camera will stay where it is pointed, and yet move easily without a jerk when force is applied to the panning handle.

The friction type have positive lock levers, and separate knobs to adjust friction pads on both pan and tilt movement. The cradle head has similar friction controls, but the pan and tilt are both accomplished on needle roller bearings for maximum smoothness. Each tripod has an elevator column, to raise the camera an extra height; this adjustment is generally preset.

The pedestal type of camera mount is more sophisticated and more expensive, having either a counterbalanced or hydraulic column and steerable wheels on the dolly. These are the types used in the broadcast business.

Guidelines: Make sure that the tripod is sufficiently strong to carry the weight of camera, lenses and any other items mounted on the camera, such as microphones. If you expect the camera to move while "on air", help the cameraman to make a smooth move by providing a good head which doesn't stick.

Other mountings are of the fixed variety such as wall or ceiling mounts. Long range planning dictates that these should be of the type where the angle of pan and tilt can be reset easily as the circumstances change rather than fixed brackets.

Don't underrate audio

The audio side of TV is much neglected and generally underrated in almost all cases. Correct audio levels are as important as correct video levels and the audio frequency ranges should be of equal standard to those of video.

To achieve these standards, a good audio mixer unit to combine the outputs of several microphones correctly should be used. The mixer amplifier should have a good gain as the output voltage signal from microphones is quite small, in the order of minus 58 db. It should have input transformers to match the impedance of the microphones, some microphones having a high impedance level up to 10 thousand ohms, others have an impedance as low as 50 ohms.

Another important feature in a good quality audio system is a audio level meter, known as a VU meter. This opens up the whole complex subject of audio levels. Suffice it to say that the standard reference program audio level is an indicated OVU on a 600 ohm line, which is the equivalent of +8 dbm where 1 dbm is the power of one milliwatt of 1000 c/s sine wave in 600 ohms.

In addition to an audio mixer unit, the audio system requires some means of monitoring for quality. The program sound can be fed into the intercom system where it can be heard on one half of the intercom headset, or alternatively it can go to an audio monitoring amplifier and speaker in the control room of the studio of a more elaborate system.

Many makes of microphones are available for ETV, the most popular being the dynamic or coil variety. Dynamic microphones vary in cost from about $45 to $200 for general purpose types. They are fairly sensitive, the higher priced ones having a good frequency range. They are intended primarily for voice pick up, and are made in several forms: levalier types to hang on a cord around the neck, stand type and the longer bodied type to be hand held.

The main points to consider when purchasing microphones is a wide frequency response to equal that of the mixer amplifier. A good sensitivity is needed to enable small voices of children to be picked up. A certain amount of directional sensitivity is desirable also, to eliminate background noise. This feature often dictates higher cost, or even a change of type to a modified ribbon directional microphone. Finally, a rugged construction is desirable if the microphones are to be handled frequently. (Ribbon microphones are quite delicate and should only be handled by technicians).

Not too much needs to be said about intercom systems. In a larger TV layout they are essential to the smooth production of a program, lesson or videotape. Ready-made intercom units are available with priority override and multiway connection, tailored to individual requirements.

Finally, lighting for ETV. Broadcast studios are hung with as many as 300 lights of as many as six different types. Closed circuit systems do not need lighting of this versatile standard.

In all probability once the lighting is set, it need not be changed during the lesson or recording. Therefore, lights sufficient to provide a nominal 30 to 50 foot candles on the subject are sufficient. The most recent innovation in lighting is the introduction of quartz iodine bulbs which give at least twice as much light as incandescent bulbs for a given wattage.

This means more compact lamps and less demand on the power circuits which is an important consideration in a normal educational building. 4000 watts (35 amps) of quartz iodine lighting should be sufficient for most applications, in the form of three 650 watt adjustable spot lights and one 1000 watt flood or flat light, substantiated by the room's normal lighting.

Once a system standard and a production standard has been established, don't let it down by poor quality accessory items; a chain is only as strong as its weakest link. ■

How ETV hardware goes together in various distribution systems

By DAVID CODLING

IN PREVIOUS articles we have been considering individual pieces of equipment, often referred to as ETV hardware. Now we look at how this hardware can best be brought together and used as a system either large or small.

It may simplify the situation if we divide systems into three parts:

1) source (local and remote)

2) recording

3) distribution (local and area)

The local source of educational TV material is televised lessons, lectures, experiments or audio visual material such as slides and film. Our TV cameras are used in each of these cases, either singly or in multiple combinations.

A one camera, one monitor system is the simplest. The camera can be set on a tripod in a classroom with a wide-angle lens to take in the teacher, blackboard, charts, etc. The monitor is at the side of the camera so that the teacher can see it. To add variety, a student could act as a cameraman, moving the camera to the teacher or blackboard as required, perhaps changing lenses on a turret at the appopriate time. An alternative is to remote control the camera, pan and tilt and zoom, with the controls by the side of the teacher or instructor.

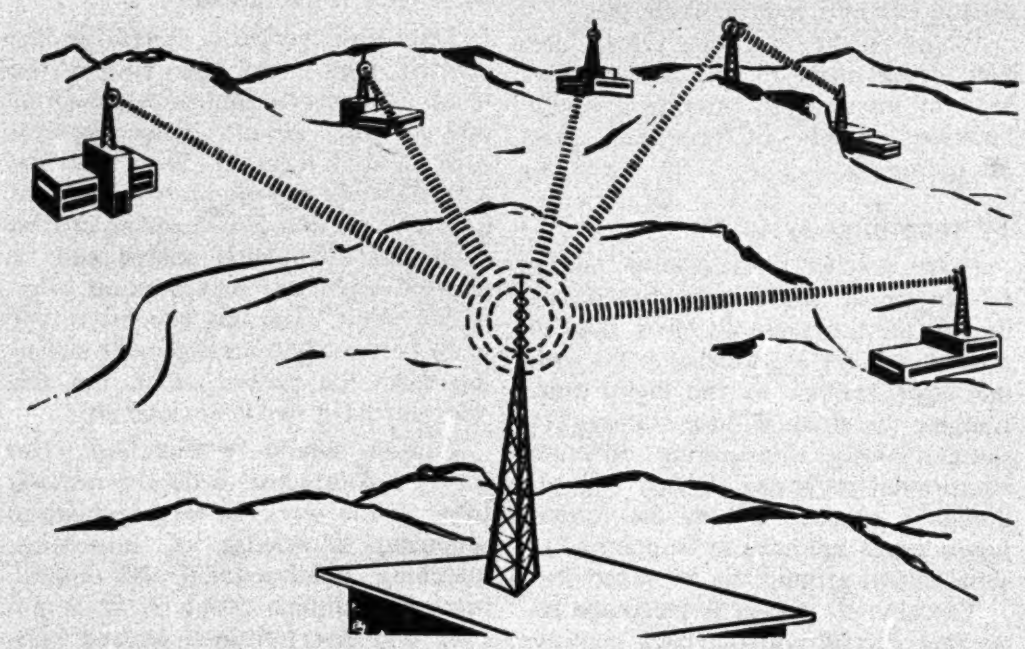
The single camera system also can be used effectively as an electronic magnifier. A camera mounted vertically can show on the screen biology specimens, crystalline structures, pages of books. It can, without modification, be centred above the eye piece of a microscope, to open up a whole new field of possibilities in group viewing.

The next step is a compact "on location" lesson record unit, of which there are several versions available. This consists of one camera, a broadcast program receiver, a monitor and a tape recorder. This is for the school which, because of location or some other reason, wishes to go it alone. It can be tied in with a local distribution system, or wheeled from room to room to record, and play back lessons and broadcast TV programs. This unit can also be effectively used as an addition to a larger system.

Where more than one camera is used, a switching device will be required to change between the picture from one camera to another. The switcher should be mounted in or on something. This suggests a desk, console or rack which becomes the 'home' of the source system.

The switcher should have several necessary qualities, interlocking switches so that a new camera selection cancels the previous one. Unselected lines should be terminated in 75 ohms to hold the video signal at its correct level. It should also be made so that it will accept the system sync pulse so that the newly selected picture is exactly in step or synchronized with previous one, to avoid causing a picture flip.

A refinement on switching between sources is to have the facility to fade or dissolve between two signal sources. In all but the most expensive, this de-



Closed-circuit system signals may be carried over-the-air via microwave or via coaxial cable. Choice depends upon distance and terrain.

vice is basically a coupled variable resistance arrangement.

The fader arm bridges between two identical "mix buses" (rows of switches): source 1, for example, is selected on Mix A, source 2 on Mix B. The fader arm is moved from A to B, and in so doing reduces source 1 in amplitude by an increasing resistance and simultaneously reduces the resistance to source 2, increasing its amplitude. Obviously to do this the two sources must again be synchronized.

The audio department is or should be complementary to the video system. Its hardware has been discussed. All that remains is to ensure that the equipment is located and operated in such a way that the correct voice or sound is occurring in coordination with the picture.

A final section, as yet unmentioned, is a telecine section. This is an arrangement whereby a vidicon camera looks at the light projected through a 16mm film or a picture slide. Care should be taken when selecting a film projector for TV use, as unfortunately just any old (or new) projector will not do.

Special shutter speed

Projectors for TV have a special shutter speed to avoid a flicker effect due to the film "pull down" occurring in the middle of a TV field. The telecine camera is also rather special as it has to cope with a succession of filmed scenes which can vary rapidly from bright to dark.

With such a collection of equipment it may be wise to turn an unused room into a studio (a room 20 x 30 ft. with no windows would do for a small studio). Mount the cameras on tripods and dollies. Cameras with viewfinders are the best for this job. Set up a microphone boom and three or four lights on stands. A film chain if possible, or a camera looking at the film projected on a wall is a useful compromise. Connect up to your console and install a videotape recorder and you are ready to go.

To summarize local TV source systems: the whole object of the exercise is to record or distribute a lesson or some educational material in such a way that the student's attention is held so that he will see and hear, and learn.

To attain this level of interest your equipment must be used wisely, to its full limit of versatility. Provide as much minute-to-minute scene variety as possible to hold attention, but not at the expense of smoothness of production under any circumstances. Changing scenes should follow a logical progression.

Try to keep these aims in view together with the overall plan when you make up your equipment list! There are experts available to help you with problems on the use of TV, production of programs, and the right equipment. It may save a lot of time and mistakes if you consult them.

Remote source systems

At present, educational material under this heading is somewhat limited, but plans for the future in some cases are absolutely astounding. The normal programs on CBC, CTV networks, together with such excellent sources as the Metropolitan Educational Television Association of Toronto and the Metropolitan Edmonton Educational Television Association are about the sum total at the moment.

The future holds 24 hour programming on UHF channels and the use of the 2500 Megacycle band of transmission frequencies. Both are being negotiated between educational boards and the BBG. These frequencies will be very useful, but have certain limitations as they can only be received in "line of site" from the transmitter. The wavelength is so short that it won't bend around buildings or over the top of hills. On the prairies this will be great but the rest of the country will have problems involving repeater stations. Ways to get around this problem are being studied in many places.

The possibility of schools being a part of the rapidly expanding CATV system is being examined. CATV means community antenna TV, being a central, very high, super-tuned antenna, with a network of cable extending from a signal distribution system. These CATV systems could be arranged to pick up regular ETV programs, UHF educational stations, and 2500 Mc/s and distribute to 10, 20 or 50 schools in a metropolitan area.

Whatever the outcome, efforts are now being made to coordinate some kind of planning to provide a vastly increased supply of broadcast programming.

TV recording systems

Every teacher who is now taking advantage of educational broadcasts has hit the timetable problem, how to arrange for the right class to be with the right teacher at the right time. Imagine the chaos if three stations are simultaneously transmitting different educational programs all day long, although I suspect that in the future, lesson times will have to be planned to some extent around the TV schedule.

The obvious answer is videotape recording, record and playback centres, tape libraries. The VTR machines have already been discussed at some length in a previous article. Now we can plan to use them in a system.

You will recall that tape interchangeability was stressed as a video recorder feature. When we visualize recording systems we see the reason for this. It is possible that recording will be carried out at a central recorder location built by a school board, a group of schools in an area, or a university campus. This recording centre may have the studio attached to it for local teachers to prepare VTR lessons suitable for their group of schools or university classes. It will also have the equipment to receive all available remote sources of educational type broadcasts.

The resulting recorded lesson or program can subsequently be distributed by physically delivering the tape to the school requiring it, where it will be played on a less expensive playback unit.

Alternatively, the playback units may be located at the same location as the recorders, being employed playing back what may become to be known as "delayed playback lessons", while the recorders are recording yet more lessons for circulation or playback. The playback signals can then be distributed on a local cable network or a CATV system or at 2500 Mc/s.

Local distribution systems

Within an individual school or college, a distribution system may exist or can be installed. An RF system may be ideal for multi-station areas, having the advantage that several lessons can be carried simultaneously on one cable. The cost of wiring such a system with coaxial cable is difficult to establish as it depends very much upon the structure of the building. A very rough guideline, however, is between $100 and $150 per room where walls have to be drilled.

The most versatile system is the "closed loop". In this system the trunk cable serves the entire school or college with tap-off connections at each desired location. With this system, not only can monitors be plugged in anywhere, but also cameras or film chains or any signal source can be inserted anywhere to act as an originating point. The less expensive type is an octupus-like arrangement radiating from the central point, but this does not have two-way flexibility.

Caution should be exercised when hiring a contractor to do the installation, as the work is very specialized requiring knowledge of impedance matching, unidirectional and omnidirectional splitters, couplers, RF amplifiers and line terminations and various other pitfalls.

Guidelines: The easiest way to

move lesson material around is on wires rather than moving the video playback unit. Plan your wiring carefully for future expansion, and the significant increase in televised educational material.

Engage a contractor who is familiar with RF or video distribution and its problems. If you plan to include color programs, make sure that the RF equipment you buy will handle chromatic signals

Area distribution systems

Area distribution probably within the jurisdiction of an area board of education or a university board of governors, is a costly business, as the signals will have to travel either through the air or on cables over considerable distances.

Through the air entails transmitters, receivers and microwave antennas or dishes, all of which are expensive at TV frequencies, and line-of-sight again applies. Cables over long lengths require repeater stations, noise limiters and phase correction units to name just three problems.

It may pay to rent existing cable facilities from a local telephone company or CATV network. The cost for this is usually determined essentially on mileage requirements and is paid for monthly during a contract for five or ten years. This kind of area distribution limits the control that an individual teacher has over what program occurs when. Although it isn't as uncontrollable as TV station programming, it is perhaps less versatile than individual playback centres in each school, backed up by a well-staffed central recording area distributing video tapes.

A further point worthy of note here: by having a playback centre in each school a teacher is able to preview the programs with a minimum of inconvenience, and by the use of a simple intercom, can arrange with the operator for instant repeat of a section of special interest.

ETV has a great amount to offer to schools and colleges. It is getting to be a complex and specialized service, however, and the planning for its use can make all the difference between success and failure. Discuss it with anyone who is willing to listen, and ask questions, you will discover amazing applications that you had never dreamed of. ■

Color ETV's wonderful but watch that price!

BY NOW almost every one has seen a color picture on a color TV set, and has discovered that color TV sets cost between $600 and $1,200.

Now color has been introduced into educational television, admittedly in a limited form, and regrettably, although understandably, at a higher price than black and white (known as monochrome) TV.

At this stage of development, all that exists in color ETV are color VTR machines which will record color broadcast programs, and play them back on modified color home receivers. This much was introduced to Canada at Canadian Education Showplace in January.

So far, nobody has a low-cost color TV camera, which means that color programs cannot as yet be originated in any place other than a broadcast studio. Let's reflect on these facts.

It's expensive and difficult

Color television is complicated, expensive, and difficult to handle, a fact that anyone at CBC or CTV will verify.

The color pictures in a chromatic system are made up of three primary colors *red*, *blue*, and *green*. All other colors, or hues, are made from combinations of these colors. The fact that we are dealing with three colors means that the TV camera now must be at least three cameras combined into one case, one for each color. (In broadcast color a fourth camera is used to provide a contrast or luminance signal). Hence the reason for the higher cost. Every camera is virtually three cameras, looking at the same scene through filter systems which split the light into the three components.

The color receiver is the reverse of the camera, receiving the three color signals separately and projecting them by a complicated system onto the face of the picture tube. In between the camera and the receiver are many mixing and processing circuits each more complicated than their black and white counterparts.

Despite all this, color ETV is coming into existence. In certain areas of educational programing it will serve a very useful purpose, such as biology, where the color of specimens is important, geography where colored maps are used, and chemistry where the color of a chemical compound is important. These areas will benefit from color but the lessons which are impossible to do in monochrome are very much in the numerical minority.

It is always more pleasing to be able to see any program in color. This is why hundreds of thousands of color TV sets will be sold in Canada this year, and this is why the low cost color VTR machines have been introduced. However, for a considerable time ETV will be a combination of monochrome and color, for no other reason than cost.

Probably the next development will be a color film chain to enable color movies to be used on the TV system in addition to broadcast programs. If all goes well in the development departments of the ETV manufacturers, we may see this in 1968, and possibly studio cameras, early in the 1970's. But watch that price.

Summing up color ETV

Color is costly to install and difficult to use (look in a TV store and I bet that you can see at least one receiver where the performers have blue or green tinted faces).

There are a certain amount of lessons where color is almost essential — almost!

If CBC and CTV have difficulty running color equipment and maintaining it, how well will your audio visual department manage?

If TV shops, which are trying to sell TV to the public, can't adjust their showroom sets properly how will the teachers in your classrooms manage?

Despite these problems, color TV is here. It's a wonderful invention and it will improve ETV lessons in both usefulness and interest value. Future developments will bring new techniques and lower costs — but tread carefully! ■